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(54) **Resin composition to be plated**

(57) A resin composition for plating comprising a thermoplastic resin and aluminum borate or amorphous silica, or both as an inorganic filler. The resin composition exhibits excellent plating characteristics and excellent electrical characteristics.

Not better than what I already have

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Description

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a resin composition which can be plated. The resin composition has superior plating characteristics and excellent electrical characteristics, and is particularly useful as a material for electric or electronic parts such as printed circuit boards, wiring circuit boards, connectors, housing, and insulators. More particularly, because the resin composition of the present invention is thermoplastic and has excellent plating and electrical characteristics, it is suitable as a material for manufacturing three dimensional circuit boards, molded interconnection devices (MID), and molded circuit boards (MCB) using injection molding techniques.

Discussion of the Background:

Because thermoplastic resin compositions having superior plating characteristics can be easily processed by injection molding or extrusion molding into three dimensional articles, such compositions are abundantly used for various electric or electronic parts, automobile parts, mechanical parts, and ornamental articles.

Conventional resin compositions capable of being plated exhibit adequate plating characteristics due to improvements in the shape and size of fillers which are added to such compositions and development in the plating technology. In addition to the excellent plating characteristics thermoplastic resins used for electronic parts, such as printed circuit boards, wiring circuit boards, connectors, housing, and insulators, must have excellent electrical characteristics.

Here, the plating characteristics indicate the capability of connecting the plated resin composition and the plating metal, that is, the adhesion between the resin composition and the metal plating film. Excellent resin-metal adhesion means excellent plating characteristics. Excellent electrical characteristics, on the other hand, are characteristics required for an insulating resin material, particularly a high frequency insulating resin material. Specifically, a material having excellent electrical characteristics must have a low dielectric constant (ε) and a low dielectric loss tangent (tan δ).

However, conventional resins and resin compositions to be plated have a high dielectric constant and a high dielectric loss tangent. For example, resins to be plated disclosed in Japanese Patent Application Laid-open Nos. 136841/1981, 230276/1993, and 98637/1989 have excellent plating characteristics and possess an extremely high value industrially. However, because of their poor electrical characteristics, application of these resins must be limited. For example, it is difficult to use these resins for electronic parts used in the high frequency wave region due to a large signal loss.

On the other hand, the adhesion strength between a molded resin and a metal plating film is largely affected by the physical characteristics of the resin surface, that is, roughness of the resin surface. In particular, the plating adhesion strength is remarkably improved by forming uniformly small anchoring pores (hereinafter called "micropores"). This is called the anchoring effect.

In many cases, a chemical etching process using an acid, an alkali, or an organic solvent is used for forming micropores on the surface of molded resins. Such micropores can be easily formed by a chemical etching process which comprises, for example, manufacturing molded articles from a resin composition comprising a prescribed amount of inorganic filler which is soluble in an acid, an alkali, or an organic solvent and immersing the molded resin surface in a specific solvent (the acid, alkali, or organic solvent) to cause the inorganic filler to dissolve out and be removed.

In this manner a resin composition comprising a thermoplastic resin and a specific inorganic filler which is soluble in an acid, an alkali, or an organic solvent has been conventionally used as the resin composition to be plated. Various fillers, such as calcium carbonate, glass, magnesium carbonate, magnesium oxide, calcium pyrophosphate, barium sulfate, barium carbonate, and zinc oxide, are used as the inorganic filler. These conventional inorganic fillers, however, impair the electrical characteristics of the resins, for example, by increasing the dielectric constant or the dielectric loss tangent. The increase in the dielectric constant or the dielectric loss tangent causes the signal loss to increase or delays the signal transmission speed, particularly when the product is used as an insulating material for electronic parts, inter alia, electronic parts for high frequency wave signals.

Here, the high frequency signals are signals of a frequency in the range of 1 GHz or larger. Specific equipment using high frequency signals includes cellular phones, PHS, pocket bells, satellite terminals, navigation systems, wireless LANs, and the like.

Conventionally, there has been no report disclosing resin compositions having both excellent plating characteristics and excellent electrical characteristics (low dielectric constant and low dielectric loss tangent).

Because of miniaturization and high integration of electronic parts in recent years, great attention is given to the technologies for manufacturing electronic parts by injection molding which is suitable for molding small and integrated parts.

An object of the present invention is therefore to provide a thermoplastic resin composition for plating, suitable for injection molding and having both excellent plating characteristics and excellent electrical characteristics.

In view of this situation the present inventors have conducted extensive studies and found that the addition of a specific inorganic filler to a thermoplastic resin produces a resin composition exhibiting both excellent plating characteristics and excellent electrical characteristics.

SUMMARY OF THE INVENTION

Accordingly, a specific object of the present invention is to provide a resin composition exhibiting both excellent plating characteristics and excellent electrical characteristics comprising a thermoplastic resin and aluminum borate or amorphous silica, or both.

Other objects, features and advantages of the invention will hereinafter become more readily apparent from the following description.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Aluminum borate and amorphous silica used in the present invention have aspect ratios of 10 or smaller, preferably 5 or smaller, and an average particle diameter of 0.01-100 μm.

The resin composition of the present invention preferably has a dielectric constant of 4.0 or smaller and a dielectric loss tangent of 0.01 or smaller in the high frequency region of 100 KHz to 300 GHz.

Resins represented by commercially available ~~thermoplastic~~ resins are used as the thermoplastic resins of the present invention. Specific examples of such thermoplastic resins include general purpose resins, such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polymethyl methacrylate (PMMA), ABS resin, and AS resins; engineering plastics, such as polyacetate (POM), polycarbonate (PC), polyphenylene ether (PPE), polyamide (PA: nylon), polyethylene terephthalate (PET), and polybutylene terephthalate (PBT); and other thermoplastic resins such as polyphenylene sulfide (PPS), polyether sulfone (PES), polyether imide (PEI), polyether ether ketone (PEEK), polyketone (PK), polyimide (PI), polycyclohexanedimethanol terephthalate (PCT), polyallylate (PAR), and various liquid crystal polymers (LCP).

These resins may be used individually or may be used as a polymer alloy or a polymer blend which is a multicomponent polymer system consisting of two or more of these resins chemically or physically blended in prescribed proportions. A denatured product of these resins can also be used. The denatured product here means a synthetic resin or a mixture of synthetic resins, of which a part of the basic component is replaced by another component when the resins are reacted or compounded.

Given as preferred combinations of resins in multicomponent polymer systems are, as binary systems, PPE/PS, PPE/PC, PPE/PA, PPE/PET, PPE/PBT, PPE/PEI, PPE/PPS, PPE/PES, PPE/PEEK, PPE/PCT, PPE/LCP, PEI/PC, PEI/PEEK, PEI/LCP, PEI/PET, PEI/PBT, LCP/PAR, LCP/PEEK, LCP/PET, LCP/PBT, LCP/PC, LCP/PCT, and LCP/PEEK, and as ternary systems, PPE/PC/PS, PPE/PEI/PC, PPE/PEI/PS, PEI/PPE/LCP, PEI/PC/LCP, PEI/PEEK/LCP, and the like.

A compatibilizer or the like may be added to these polymer alloys or polymer blends to improve compatibility among the polymers. Given as examples of specific compatibilizers which can be used are copolymers of epoxy-modified-MMA and MMA; copolymers of epoxy-modified-St and St; copolymers of epoxy-modified-St and MMA; copolymers of epoxy-modified-MMA and St; copolymers of St and maleic anhydride; copolymers of St and MMA; and copolymers of maleic anhydride and vinyl compound. These copolymers may be random copolymers, block copolymers, alternating copolymers, or graft copolymers.

The thermoplastic resin used in the present invention may contain various additives which may improve the basic characteristics of the resins, such as mechanical characteristics, electrical characteristics, heat resistance, molding processability, fluidity, flame retarding characteristics, UV resistance, chemical resistance, and outward appearance of the molded products, and to provide a color or glossiness to the products. Plasticizers, thermal stabilizers, oxidation stabilizers, cross-linking agents, flame retardants, UV absorbers, coloring agents, glossing agents, and the like are given as examples of specific additives.

The inorganic fillers used in the present invention which are aluminum borate and amorphous silica are respectively shown by the following formulas:

$$nAl_2O_3 \cdot mB_2O_3 \qquad (1)$$

wherein n and m individually represent an integer of 1-100, and

$$SiO_2 \qquad (2)$$

Aluminum borate is industrially manufactured from Al_2O_3 and B_2O_3 by a method called an external flux process.

The amorphous silica is preferably that containing 96% or more, preferably 99% or more, of silicon oxide (SiO_2). Such an amorphous silica is manufactured, for example, by melting quartz (crystalline silica) and cooling the molten silica. The dielectric constant and dielectric loss tangent are high if the amount of silicone oxide in the amorphous silica is less than 96%.

not fiber

The aluminum borate and amorphous silica used in the present invention are powdery or globular fillers having an aspect ratio, which is the ratio of the length along the long axis to the length along the short axis, of 10 or less, preferably 5 or less, and an average diameter of 0.01-100 μm, preferably 0.1-50 μm . The closer the aspect ratio to 1, that is, the closer the shape of the filler to a sphere, the greater the degree of improvement in the plating characteristics. If the aspect ratio is too large, specifically larger than 10, the shape of the micropores is fibrous, remarkably decreasing the plate adhesion strength. If the average particle diameter is less than 0.01 μm , it is difficult for the catalysts for non-electrolytic plating to adhere to the surface of the molded product. This results not only in insufficient adhesion strength, but also uneven plating. If the average particle diameter is larger than 100 μm , the micropores are too large to provide sufficient anchoring. As a result, only weak physical bonding is obtained between the plated film and the resin.

The amount of the inorganic filler, that is, aluminum borate or amorphous silica, is 5-70 parts by weight, preferably 10-60 parts by weight, for 100 parts by weight of the total amount of the thermoplastic resin and the inorganic filler. If the amount of the inorganic filler is less than 5 parts by weight, sufficient plating adhesion strength cannot be obtained; if larger than 70 parts by weight, the fluidity of the resulting resin composition is remarkably lowered and molding processability is impaired.

In order to improve dispersibility and affinity to the resin, thermal stability and oxidation stability, the inorganic fillers used in the present invention may be surface-treated by a conventional method.

The addition of a coupling agent is given as an example of the method of surface treatment. Given as examples of coupling agents which can be preferably used are silane coupling agents, such as vinyltrichlorosilane, vinyltris(β-methoxyethoxy)silane, vinyltriethoxysilane, vinyltrimethoxysilane, γ-methacryloxypropyltrimethoxysilane, β-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, γ-glycidoxypropyltrimethoxysilane, γ-glycidoxypropylmethyldiethoxysilane, N-β-(aminoethyl)-γ-aminopropyltrimethoxysilane, N-β-(aminoethyl)-γ-aminopropylmethyldimethoxysilane, γ-aminopropyltriethoxysilane, N-phenyl-γ -aminopropyltrimethoxysilane, γ-mercaptopropyltrimethoxysilane, γ-chloropropyltrimethoxysilane, di(3-triethoxysilylpropyl)tetrasulfide, 3-mercaptopropyltrimethoxysilane, 2-mercaptoethyltrimethoxysilane, 3-aminopropyltriethoxysilane, N-2(aminoethyl)-3-aminopropyltrimethoxysilane, vinyltri(2-methoxyethoxy)silane, 3-methacryloyloxypropyltrimethoxysilane, and 3-glycidyloxypropyltrimethoxysilane; and titanate coupling agents, such as triisostearoylisopropyl titanate, di(dioctylphosphate)diisopropyl titanate, didodecylbenzenesulfonyldiisopropyl titanate, and diisostearyldiisopropyl titanate.

These coupling agents can be used in an amount which does not impair the electrical characteristics or plating characteristics, usually in an amount of 0.0001-1 part by weight for 100 parts by weight of the inorganic filler.

Aluminum borate and amorphous silica which are incorporated in a thermoplastic resin as an inorganic filler in the resin composition of the present invention may be used either individually or in combination.

Further, it is possible to use inorganic fillers other than aluminum borate and amorphous silica to an extent which does not impaire the electrical characteristics and plating characteristics. Given as examples of such other inorganic fillers which can be used together are glass, glass single fiber, glass fiber, glass balloons, shirasu balloons, chopped strands, carbon fiber, carbon, carbon black, alamide, potassiumtatanate, magnesium borate, calcium carbonate, magnesium carbonate, magnesium sulfate, calcium sulfate, aluminum sulfate, pyrophosphate, silicon nitride, aluminum nitride, boron nitride, silicon carbide, alumina, alumina fiber, silica, mica, talc, diatomaceous earth, clay, volcanic ash, lime stone, bentonite, titanium oxide, magnesium oxide, calcium oxide, molybdenum disulfide, and the like.

The resin composition of the present invention can be manufactured by a conventional process for manufacturing common composite materials. Industrially, a melt-kneading method is preferred in view of productivity and economy. Specific examples of such methods include a kneading method using a biaxial or uniaxial extruder, and a method using a batch-type heating melt-kneader which is typified by the laboplast mill.

Because the resin composition of the present invention is thermoplastic, injection molding or extrusion molding can be used for manufacturing molded products from the resin composition. Films or membranes can also be manufactured by a solvent cast method using an organic solvent or the like.

In the same way as in the case of conventional resin compositions for plating, the strength of adhesion between the molded products made from the resin composition of the present invention and the plating metal film (the plating adhesion strength) depends on the physical characteristics of the molded surface of the resin composition, specifically the roughness of the molded resin surface. It is possible to remarkably improve the plating adhesion strength from the anchoring effect obtained by forming uniform micropores of an appropriate size on the surface of the molded article before plating.

In the same manner as in the case of molded products made from conventional resin compositions for plating, chemical etching is effective for producing the micropores. As mentioned above, the chemical etching can be carried

out by immersing the molded resin surface in an acid, alkali, or organic solvent, or the like and dissolving and removing the inorganic filler from the surface of the molded article.

Because aluminum borate and amorphous silica used in the present invention is soluble in alkaline aqueous solutions, it is possible to dissolve aluminum borate or amorphous silica and remove these from the surface of molded articles by chemically etching that surface with an alkaline aqueous solution, thereby producing micropores which are effective for plating. As the alkaline aqueous solution, aqueous solutions of sodium hydroxide, potassium hydroxide, lithium hydroxide, and the like are preferred in view of the solubility of aluminum borate and amorphous silica, and also in view of economy. These alkaline aqueous solution may be used either individually or mixed. The preferred concentration of the alkaline aqueous solution is in the range of 1 N to 15 N, and particularly in the range of 3 N to 12 N. If the alkali concentration is too small, it takes a long time for the aluminum borate or amorphous silica to dissolve out; if the concentration is too high, the resin may exhibit conspicuous deterioration, resulting in a decrease in the plating adhesion strength.

In the case where inorganic fillers other than aluminum borate or amorphous silica are used, these other inorganic fillers may be chemically etched together with aluminum borate and amorphous silica. In this case, the etching solution is selected taking into consideration the characteristics (e.g., the solubility, corrosivity, etc.) of such other inorganic fillers. For instance, when calcium carbonate, pyrophosphate, or barium sulfate is used together with aluminum borate or amorphous silica, an acid, such as sulfuric acid, hydrochloric acid, chromic acid, phosphoric acid, acetic acid, or boric acid, a mixture of two or more of these acids, or aqueous solution of one or more of these acid can be used. When glass-type or alumina-type fillers are used together, an alkali, such as an aqeous solution of potassium hydroxide, sodium hydroxide, or lithium hydroxide, or mixture of these, at any optional concentration, can be used.

In any of the above cases, the chemical etching is carried out at room temperature (20°C) to 120°C, preferably at a temperature of 50°C to 100°C. If the etching temperature is too low, it takes a long time for the inorganic fillers to dissolve out; if too high, deterioration of the resin is conspicuous.

To improve the rate of dissolution of the organic fillers it is possible to agitate the mixture, irradiate the mixture with ultrasonic waves, or bubble air through the mixture, during the chemical etching.

In addition, to carry out the chemical etching more effectively a procedure called pre-etching, which consists of exposing the inorganic fillers by dissolving the resin on the surface of molded article (a skin layer of resin), may be applied. Conventional methods of pre-etching can be used. Among organic solvents, alkaline solutions, and acids commonly used for pre-etching, organic solvents or acids are particularly preferred in the present invention. Preferred organic solvents used for pre-etching are, for example, chloroform, dichloromethane, benzene, toluene, xylene, pyridine, hexane, tetrahydrofuran, acetonitrile, ethyl acetate, N,N-dimethylformamide, N-methylpyrrolidone, and dimethylsulfoxide. Sulfuric acid, hydrochloric acid, chromic acid, nitric acid, or phosphoric acid, or mixtures of these are given as preferred examples of the acids.

Except for the chemical etching step and the pre-etching step, the molded products produced from the resin composition of the present invention may be plated by non-electrolyte plating or electrolytic plating in the same manner as in conventional resin compositions for plating.

As previously mentioned, the resin composition of the present invention preferably has a dielectric constant of 4.0 or less and a dielectric loss tangent of 0.01 or less in the high frequency region of 100 KHz to 300 GHz. Resin compositions having a dielectric constant greater than 4.0 or a dielectric loss tangent greater than 0.01 in the above frequency region may unduly increase signal loss when used as an insulating material for electronic parts, particularly the electronic parts or materials used in a high frequency region of 1 GHz or greater, making it difficult to reasonably design circuits and the like. Such parts or materials are unusable in some on applications.

Other features of the invention will become apparent in the course of the following description of the exemplary embodiments which are given for illustration of the invention and are not intended to be limiting thereof.

EXAMPLES

The aluminum borate used in the examples and comparative examples hereinbelow consists of rhombic system crystals having a chemical formula of $9Al_2O_3 \cdot 2B_2O_3$, and made from Al_2O_3 and B_2O_3 by the external flux method.

Amorphous silica used in the examples and comparative examples was made by melting quartz (crystalline silica) with an SiO_2 purity of 99.9% or more, and cooling the molten silica.

The following resins were used in the examples and comparative examples.

- PEI: Polyether imide, Ultem 1000™, manufactured by GE Plastics Japan Ltd.
- PPE: Denatured polyphenylene ether, XYRON PXL X9102™, manufactured by Asahi Chemical Industry Co., Ltd.
- LCP: Liquid crystal polymer, SUMIKASUPER LCP E6000™, manufactured by Sumitomo Chemical Co., Ltd.
- PA: Nylon 6, NOVAMID 1013C™, manufactured by Mitsubishi Chemical Corp.
- POM: Polyacetate, Tenac 3010™, manufactured by Asahi Chemical Industry Co., Ltd.

- PBT: Polybutylene terephthalate, Teijin PBT CN-7000™, manufactured by Teijin Co.
- PEEK: Polyether ether ketone, VICTREX 45G™, manufactured by Sumitomo Chemical Co., Ltd.
- PPS: Polyphenylene sulfide, Lightone R-4™, manufactured by Dainippon ink and chemicals, Inc.
- PC: Polycarbonate, NOVAREX 7022A™, manufactured by Mitsubishi Chemical Corp.

Example 1-54

⟨Preparation of resin compositions to be plated⟩

Thermoplastics, aluminum borate, and amorphous silica were pre-blended in the proportions shown in Tables 1-1 to 1-4. The mixture was fed into a biaxial extruder (ZE40A™, manufactured by Hermann Berstorff Maschinenban GmbH) using a quantitative feeder at a rate of 20-60 kg/hour, and melt-kneaded at the temperatures and rotations shown in Tables 2-1 to 2-4. After cooling, the strands were cut by a pelletizer to produce pellets.

⟨Molding⟩

The pellets were dried at 100-150°C in a thermostat and molded by an injection molding machine (F-85™, manufactured by Klockner Ferromatik Desma GmbH) at the molding temperatures shown in Tables 2-1 to 2-4 to prepare test leaves for the evaluation of plating characteristics and electrical characteristics. The shapes of the test leaves were as follows.

⟨Shapes of test leaves⟩

- ASTM #1 Dumbbell: for the evaluation of plating characteristics
- Disc 1, ϕ 100 mm x 1.6 mm: for the evaluation of electrical characteristics in the frequency range of 1-15 MHz
- Disc 2, ϕ 100 mm x 0.8 mm: for the evaluation of electrical characteristics in the frequency range of 1-25 GHz

⟨Plating⟩

The above test leaves were de-fatted by treating with Ace Clean A220™ manufactured by Okuno Chemical Industries Co., Ltd. at 60°C for 5 minutes and washed with water. The flat surface of the test leaves was chemically etched under the conditions shown in Tables 3-1 to 3-4 or Table 8. After chemical etching, the test leaves were neutralized with 5 g/l NaOH aqueous solution or 5 ml/l HCl aqueous solution at 25°C for 3 minutes followed by washing with water, conditioned with 150 ml/l of Condilizer SP™ manufactured by Okuno Chemical Industries Co., Ltd. at 50°C for 4 minutes followed by washing with water. The test leaves were then catalyzed with 60 ml/l of Catalyst C™ manufactured by Okuno Chemical Industries Co., Ltd. and 150 ml/l HCl at room temperature for 4 minutes, followed by washing with water, and activated with 5 wt% HCl acqueous solution at 25°C for two minutes. After washing with diluted H_2SO_4, the test leaves were non-electrolytically plated in OPC-750™ manufactured by Okuno Chemical Industries Co., Ltd. using 100 ml/l of A solution, 100 ml/l of B solution, and 2ml/l of C solution, followed, after washing with diluted H_2SO_4, by electroplating (copper plate, thickness: 40 μm) in a copper sulfate bath (120-250 g/l of $CuSO_4 \cdot 5H_2O$; 30-100 g/l of H_2SO_4; 20-80 mg/l of Cl^- ion) under the conditions of the electric current density of 1-20 A/dm^2, the bath voltage of 1-5 V and the source voltage of 6-8 V.

⟨Evaluation of plating characteristics⟩

- Evaluation of surface conditions after chemical etching

The test leaves (ASTM #1 Dumbbell) were dried after chemical etching . A cellophane tape (width: 18 mm, manufactured by Nichiban Co., Ltd.) was attached to the chemically etched surface and pressed (pressure: about 500 g) to attach the tape to the surface of the test leaf. The tape was then peeled off uninterruptedly at an angle of 90° to evaluate the peelability of the surface layer by macroscopic observation. The results are classified as follows:

◎ There was no release of resin from the surface whatsoever.
○ There was almost no release of resin from the surface.
△ Part of the surface resin was released.
X The resin surface was attached to the tape and released with the tape.

• Evaluation of external appearance of plated surface

After electroplating, the external appearance of the plated surface (uniformity of plated film, presence or absence of plating swelling) was macroscopically observed according to the following criteria.

(Uniformity of plated film)

◎	The surface was uniform and mirror-like
○	The surface was uniform and almost mirror-like.
△	Part of the surface was not uniform.
X	The surface was not uniform as a whole.

(Swelling of plated film)

◎	There was no swelling of the plated film whatsoever.
○	There was almost no swelling of the plated film.
△	Part of the plated film exhibited swelling.
X	Complete swelling of the plated film was observed.

• Measurement of plate film adhesion strength

After electroplating, a stripe 1 cm in width was cut out with a cutter knife. The tip of the stripe was pulled upward at 90° and this tip was attached to a spring to measure the strength required to release the plated film (kg/cm).

(Evaluation of electrical characteristics)

• Measurement of dielectric constant and dielectric loss tangent

Measured wave length: 1 MHz, 10 MHz, 1GHz, 10GHz, 20 GHz
Measurement temperature: 25°C
Measuring method:

(1) Parallel plate electrode method (1-15 MHz)
(2) Triplate line resonator method (Loss separation method; 1-25 GHz)

The results of evaluation of peelability of the surface layer and plating characteristics after chemical etching are shown in Tables 3-1 to 3-4. The results of evaluation of the electrical characteristics are shown in Tables 4-1 to 4-4.

TABLE 1-1

Example No.	Resin		Inorganic Filler (Aluminum borate)		
	Types	Amount (wt%)	Amount (wt%)	Average Diameter (μm)	Aspect Ratio (Average)
1	PEI	80	20	2.5	1.5
2	PEI	60	40	2.5	1.5
3	PEI	50	50	2.5	1.5
4	PEI	50	50	4.0	1.5
5	PEI	50	50	7.0	1.5
6	PEI	50	50	8.0	1.4
7	PEI	50	50	8.0	3.0
8	PEI	50	50	8.0	5.5
9	PEI	50	50	8.0	8.5
10	PEI	50	50	30.0	1.5
11	PPE	50	50	2.5	1.5
12	POM	50	50	2.5	1.5
13	PA	50	50	2.5	1.5
14	PBT	50	50	2.5	1.5
15	PEEK	50	50	2.5	1.5
16	PPS	50	50	2.5	1.5
17	LCP	50	50	2.5	1.5

TABLE 1-2

Example No.	Resin		Inorganic Filler (Amorphous silica)		
	Types	Amount (wt%)	Amount (wt%)	Average Diameter (μm)	Aspect Ratio (Average)
18	PEI	80	20	5.2	1.4
19	PEI	70	30	5.2	1.4
20	PEI	60	40	5.2	1.4
21	PEI	40	60	5.2	1.4
22	PEI	60	40	3.1	1.5
23	PEI	60	40	1.2	1.3
24	PEI	60	40	7.9	1.4
25	PEI	60	40	27.0	1.3
26	PEI	60	40	3.1	3.0
27	PEI	60	40	3.1	7.8
28	PPE	60	40	5.2	1.4
29	POM	60	40	5.2	1.4
30	PA	60	40	5.2	1.4
31	PBT	60	40	5.2	1.4
32	PEEK	60	40	5.2	1.4
33	PPS	60	40	5.2	1.4
34	LCP	60	40	5.2	1.4
35	PPE	60	40	0.1	1.6
36	PPE	60	40	50	1.2
37	PPE	30	70	5.2	1.4
38	PPE	90	10	5.2	1.4
39	PPE	95	5	5.2	1.4

TABLE 1-3

Example No.	Resin		Inorganic Filler (Aluminum borate)		
	Types	Amount (wt%)	Amount (wt%)	Average Diameter (μm)	Aspect Ratio (Average)
40	PEI/PPE	25/25	50	8.0	1.4
41	PEI/PPE	30/20	50	8.0	1.4
42	PEI/PPE/LCP	20/20/10	50	8.0	1.4
43	PA/PPE	25/25	50	8.0	1.4

TABLE 1-4

Example No.	Resin		Inorganic Filler (Amorphous silica)		
	Types	Amount (wt%)	Amount (wt%)	Average Diameter (μm)	Aspect Ratio (Average)
44	PEI/PPE	25/25	50	5.2	1.4
45	PEI/PPE	30/20	50	5.2	1.4
46	PEI/PPE	20/30	50	5.2	1.4
47	PEI/PPE/LCP	20/20/10	50	5.2	1.4
48	PPE/PA	25/25	50	5.2	1.4
49	PPE/PC	25/25	50	5.2	1.4
50	PEI/PC	30/20	50	5.2	1.4
51*1	PEI/PPE	18/42	40	5.2	1.4
52*2	PEI/PPE	18/42	40	5.2	1.4
53*3	PEI/PPE	18/42	40	5.2	1.4
54*4	PEI/PPE	18/42	20/20*5	8.0/5.2*6	1.4

*1 : 5 wt% of an epoxy denatured St-MMA copolymer was added as a compatibilizer for resins.
*2 : 1 wt% of titanium oxide was added as a coloring agent.
*3 : 0.001 wt% of γ-aminopropyltriethoxy silane was added as a silane coupling agent for amorphous silica.
*4 : A mixture of aluminum borate and amorphous silica was used as the inorganic filler.
*5 : Aluminum borate/amorphous silica
*6 : Aluminum borate/amorphous silica

TABLE 2-1

Example No.	Kneading Conditions		Injection Nozzle Temperature
	Temperature	Rotation	
	(°C)	rpm	(°C)
1	300	100	340
2	300	100	350
3	300	100	360
4	300	100	360
5	300	100	360
6	300	100	360
7	300	100	360
8	300	100	360
9	300	100	360
10	300	100	340
11	280	150	300
12	220	150	220
13	250	150	250
14	370	120	250
15	330	100	380
16	320	100	340
17	300	100	340

TABLE 2-2

Example No.	Kneading Conditions		Injection Nozzle Temperature
	Temperature	Rotation	
	(°C)	rpm	(°C)
18	300	150	310
19	300	150	310
20	300	150	320
21	300	150	340
22	300	150	320
23	300	150	320
24	300	150	320
25	300	150	320
26	300	150	320
27	300	150	320
28	260	150	290
29	210	150	220
30	250	150	260
31	240	150	260
32	350	150	390
33	320	150	340
34	340	150	340
35	260	140	290
36	260	150	290
37	270	100	300
38	260	150	290
39	260	150	290

TABLE 2-3

Example No.	Kneading Conditions		Injection Nozzle Temperature
	Temperature	Rotation	
	(°C)	rpm	(°C)
40	300	100	320
41	300	100	330
42	290	100	330
43	320	120	300

TABLE 2-4

Example No.	Kneading Conditions		Injection Nozzle Temperature
	Temperature	Rotation	
	(°C)	rpm	(°C)
44	300	150	320
45	300	150	320
46	300	150	320
47	300	150	330
48	280	150	300
49	250	150	260
50	280	150	300
51	300	150	320
52	300	150	320
53	300	150	320
54	300	150	320

TABLE 3-1

Example No.	Chemical Etching Conditions				Surface	Evaluation of plated film		
	Soln.	Conc.	Temp. (°C)	Time (min)	Peelability	Appearance		Adhesion
						Uniformity	Swelling	(Kg/cm)
1	Acq.KOH	8N	95	120	○	◎	◎	1.21
2	Acq.KOH	8N	95	120	◎	◎	◎	1.44
3	Acq.KOH	8N	95	120	◎	◎	◎	1.85
4	Acq.KOH	8N	95	120	◎	◎	◎	1.70
5	Acq.KOH	8N	95	120	◎	◎	◎	1.71
6	Acq.KOH	8N	95	120	◎	◎	◎	1.66
7	Acq.KOH	8N	95	120	◎	◎	◎	1.51
8	Acq.KOH	8N	95	120	◎	◎	◎	1.50
9	Acq.KOH	8N	95	120	◎	◎	◎	1.42
10	Acq.KOH	8N	95	120	◎	◎	◎	1.50
11	Acq.KOH	8N	80	90	◎	◎	◎	1.89
12	Acq.KOH	8N	80	90	◎	◎	◎	1.77
13	Acq.KOH	8N	80	90	◎	◎	◎	1.74
14	Acq.KOH	8N	80	60	○	◎	◎	1.44
15	Acq.KOH	8N	95	120	◎	◎	◎	1.80
16	Acq.KOH	8N	95	120	◎	◎	◎	1.56
17	Acq.KOH	8N	80	60	○	◎	◎	1.63

TABLE 3-2

Example No.	Chemical Etching Conditions				Surface	Evaluation of plated film		
	Soln.	Conc.	Temp. (°C)	Time (min)	Peelability	Appearance		Adhesion
						Uniformity	Swelling	(Kg/cm)
18	Acq.KOH	8N	90	60	◎	◎	◎	1.36
19	Acq.KOH	8N	90	90	◎	◎	◎	1.49
20	Acq.KOH	8N	90	90	◎	◎	◎	1.88
21	Acq.KOH	8N	90	90	◎	◎	◎	1.95
22	Acq.KOH	8N	90	90	◎	◎	◎	1.51
23	Acq.KOH	8N	90	90	◎	◎	◎	1.47
24	Acq.KOH	8N	90	90	◎	◎	◎	1.48
25	Acq.KOH	8N	90	90	◎	◎	◎	1.35
26	Acq.KOH	8N	90	90	◎	◎	◎	1.45
27	Acq.KOH	8N	90	120	◎	◎	◎	1.41
28	Acq.KOH	8N	90	60	◎	◎	◎	1.56
29	Acq.KOH	8N	90	90	◎	◎	◎	1.52
30	Acq.KOH	8N	90	90	◎	◎	◎	1.47
31	Acq.KOH	8N	90	90	◎	◎	◎	1.48
32	Acq.KOH	8N	90	90	◎	◎	◎	1.72
33	Acq.KOH	8N	90	90	◎	◎	◎	1.31
34	Acq.KOH	8N	90	90	◎	◎	◎	1.57
35	Acq.KOH	8N	90	90	◎	◎	◎	1.21
36	Acq.KOH	8N	90	90	◎	◎	◎	1.78
37	Acq.KOH	8N	90	90	◎	◎	◎	1.23
38	Acq.KOH	8N	90	90	◎	◎	◎	1.10
39	Acq.KOH	8N	90	90	○	○	○	1.02

TABLE 3-3

Example No.	Chemical Etching Conditions				Surface	Evaluation of plated film		
	Soln.	Conc.	Temp. (°C)	Time (min)	Peelability	Appearance		Adhesion
						Uniformity	Swelling	(Kg/cm)
40	Acq.KOH	8N	95	120	○	◎	◎	1.89
41	Acq.KOH	8N	95	120	◎	◎	◎	1.89
42	Acq.KOH	8N	80	90	◎	◎	◎	1.48
43	Acq.KOH	8N	80	90	◎	◎	◎	1.41

TABLE 3-4

Example No.	Chemical Etching Conditions				Surface	Evaluation of plated film		
	Soln.	Conc.	Temp. (°C)	Time (min)	Peelability	Appearance		Adhesion
						Uniformity	Swelling	(Kg/cm)
44	Acq.KOH	8N	90	90	◎	◎	◎	1.71
45	Acq.KOH	8N	90	90	◎	◎	◎	1.63
46	Acq.KOH	8N	90	90	◎	◎	◎	1.69
47	Acq.KOH	8N	90	90	◎	◎	◎	1.53
48	Acq.KOH	8N	90	90	◎	◎	◎	1.41
49	Acq.KOH	8N	90	90	◎	◎	◎	1.54
50	Acq.KOH	8N	90	90	◎	◎	◎	1.63
51	Acq.KOH	8N	90	90	◎	◎	◎	1.63
52	Acq.KOH	8N	90	90	◎	◎	◎	1.65
53	Acq.KOH	8N	90	90	◎	◎	◎	1.42
54	Acq.KOH	8N	90	90	◎	◎	◎	1.77

TABLE 4-1

Example No.	1 MHz	10 MHz	1 GHz	10 GHz	20 GHz
(Upper row: Dielectric constant Lower row: Dielectric loss tangent)					
1	3.25 0.004	3.24 0.004	3.15 0.005	3.14 0.006	3.12 0.007
2	3.30 0.004	3.30 0.005	3.29 0.007	3.24 0.007	3.22 0.007
3	3.31 0.005	3.30 0.005	3.30 0.006	3.26 0.007	3.24 0.007
4	3.31 0.005	3.29 0.006	3.29 0.007	3.28 0.007	3.26 0.008
5	3.30 0.004	3.30 0.004	3.28 0.006	3.28 0.007	3.26 0.007
6	3.30 0.006	3.29 0.006	3.28 0.006	3.28 0.007	3.27 0.008
7	3.31 0.005	3.30 0.005	3.28 0.006	3.28 0.007	3.28 0.007
8	3.29 0.005	3.28 0.006	3.26 0.006	3.26 0.006	3.26 0.007
9	3.30 0.005	3.30 0.006	3.29 0.007	3.26 0.007	3.26 0.007
10	3.23 0.002	3.23 0.002	3.22 0.003	3.22 0.003	3.20 0.003
11	2.44 0.001	2.44 0.001	2.43 0.001	2.42 0.001	2.41 0.001
12	3.65 0.005	3.65 0.006	3.61 0.006	3.60 0.007	3.58 0.007
13	3.41 0.009	3.41 0.009	3.38 0.009	3.36 0.009	3.35 0.009
14	3.23 0.001	3.22 0.001	3.20 0.001	3.18 0.001	3.18 0.001
15	3.10 0.003	3.10 0.003	3.07 0.003	3.07 0.004	3.04 0.004
16	3.52 0.004	3.52 0.004	3.50 0.004	3.50 0.004	3.48 0.006
17	3.61 0.008	3.60 0.008	3.58 0.008	3.55 0.009	3.55 0.009

TABLE 4-2

(Upper row: Dielectric constant Lower row: Dielectric loss tangent)					
Example No.	1 MHz	10 MHz	1 GHz	10 GHz	20 GHz
18	3.15 0.003	3.14 0.004	3.10 0.005	3.10 0.005	3.10 0.006
19	3.19 0.003	3.18 0.004	3.12 0.005	3.12 0.006	3.11 0.006
20	3.20 0.004	3.19 0.004	3.15 0.005	3.14 0.005	3.13 0.006
21	3.25 0.003	3.24 0.003	3.24 0.004	3.22 0.005	3.20 0.005
22	3.21 0.003	3.20 0.004	3.17 0.004	3.15 0.005	3.13 0.005
23	3.20 0.003	3.20 0.003	3.15 0.004	3.15 0.005	3.14 0.006
24	3.20 0.003	3.19 0.004	3.18 0.005	3.14 0.005	3.14 0.006
25	3.21 0.004	3.20 0.004	3.17 0.005	3.15 0.006	3.15 0.006
26	3.20 0.003	3.20 0.004	3.19 0.005	3.16 0.006	3.13 0.007
27	3.21 0.003	3.19 0.004	3.17 0.004	3.16 0.005	3.15 0.006
28	2.92 0.001	2.90 0.001	2.89 0.002	2.88 0.002	2.86 0.002
29	3.62 0.005	3.61 0.005	3.60 0.006	3.58 0.006	3.56 0.007
30	3.34 0.007	3.34 0.008	3.32 0.008	3.31 0.009	3.30 0.009
31	3.21 0.001	3.19 0.001	3.18 0.001	3.17 0.001	3.17 0.001
32	3.08 0.002	3.06 0.002	3.04 0.003	3.02 0.003	3.01 0.003
33	3.49 0.004	3.48 0.004	3.46 0.005	3.45 0.005	3.44 0.005
34	3.59 0.007	3.58 0.007	3.58 0.007	3.58 0.005	3.58 0.004
35	2.88 0.001	2.87 0.001	2.86 0.001	2.86 0.001	2.85 0.001

TABLE 4-2 (continued)

(Upper row: Dielectric constant Lower row: Dielectric loss tangent)					
Example No.	1 MHz	10 MHz	1 GHz	10 GHz	20 GHz
36	2.89	2.89	2.87	2.85	2.84
	0.001	0.001	0.002	0.002	0.002
37	2.98	2.97	2.95	2.94	2.93
	0.002	0.002	0.003	0.003	0.003
38	2.68	2.67	2.65	2.64	2.64
	0.002	0.001	0.002	0.002	0.002
39	2.65	2.64	2.62	2.61	2.60
	0.002	0.002	0.002	0.002	0.003

TABLE 4-3

(Upper row: Dielectric constant Lower row: Dielectric loss tangent)					
Example No.	1 MHz	10 MHz	1 GHz	10 GHz	20 GHz
40	2.56	2.54	2.49	2.48	2.48
	0.003	0.003	0.004	0.004	0.005
41	2.69	2.69	2.67	2.67	2.67
	0.004	0.004	0.005	0.005	0.005
42	2.89	2.86	2.86	2.85	2.82
	0.006	0.006	0.006	0.006	0.007
43	3.01	3.00	3.00	3.00	3.00
	0.006	0.007	0.007	0.007	0.007

TABLE 4-4

(Upper row: Dielectric constant Lower row: Dielectric loss tangent)					
Example No.	1 MHz	10 MHz	1 GHz	10 GHz	20 GHz
44	3.01	3.00	2.97	2.96	2.95
	0.003	0.003	0.003	0.003	0.003
45	3.02	3.01	2.99	2.99	2.98
	0.003	0.004	0.004	0.004	0.004
46	2.98	2.97	2.95	2.94	2.93
	0.003	0.003	0.003	0.004	0.004
47	2.99	2.98	2.97	2.96	2.96
	0.004	0.005	0.005	0.005	0.006
48	2.98	2.97	2.95	2.95	2.94
	0.005	0.006	0.007	0.007	0.007
49	2.82	2.81	2.79	2.78	2.77
	0.003	0.003	0.003	0.004	0.005
50	2.99	2.98	2.97	2.96	2.96
	0.003	0.003	0.004	0.004	0.005
51	2.79	2.78	2.76	2.76	2.75
	0.002	0.002	0.002	0.002	0.002
52	2.85	2.84	2.85	2.83	2.83
	0.002	0.002	0.002	0.003	0.003
53	2.85	2.84	2.82	2.81	2.79
	0.001	0.001	0.002	0.002	0.002
54	2.92	2.91	2.89	2.87	2.86
	0.003	0.003	0.003	0.004	0.004

Comparative Examples 1-14

⟨Preparation of Resin compositions to be Plated⟩

Thermoplastic resins and inorganic fillers were pre-blended in the proportions shown in Table 5. The mixtures were fed into a biaxial extruder (ZE40A™, manufactured by Hermann Berstorff Maschinenban GmbH) using a quantitative feeder at a rate of 40-60 kg/hour, and melt-kneaded at the temperatures and rotations shown in Table 6. After cooling with water, the strands were cut by a pelletizer to produce pellets.

⟨Molding⟩

The pellets were molded in the same manner as in Examples 1-54 except for those items listed in Table 6, thereby preparing test leaves for the evaluation of plating characteristics and electrical characteristics.

(Plating, Evaluation of Plating Characteristics, and Evaluation of Electrical Characteristics)

The same procedures as in Examples 1-54 were followed in principle, except that for the chemical etching conventional solvents were used under the conventionally reported conditions (temperatures and reaction time) shown in Table 7.

The results of evaluation of surface layer peelability and plating characteristics after chemical etching are shown together in Table 7 and the results of evaluation of electrical characteristics are shown in Table 8.

TABLE 5

Comparative Example No.	Resin		Inorganic Filler		
	Types	Amount (wt%)	Amount (wt%)	Average Diameter (μm)	Aspect Ratio (Average)
1	PEI	50	Glass fiber		
			50	-	80
2	PEI	50	Calcium pyrophosphate		
			50	10	1.2
3	PEI	50	Calcium carbonate		
			50	8	1.3
4	PEI	50	Barium sulfate		
			50	5	1.4
5	PEI	50	Glass beads		
			50	10	1.1
6	PEI	50	Aluminum oxide		
			50	15	1.3
7	LCP	50	Calcium pyrophosphate		
			50	10	1.2
8	PPE	50	Calcium carbonate		
			50	8	1.3
9	PPE	50	Calcium pyrophosphate		
			50	10	1.2
10	PA	50	Calcium pyrophosphate		
			50	10	1.2
11	PEI/PPE	25/25	Calcium pyrophosphate		
			50	10	1.2
12	PEI/PPE	30/20	Calcium pyrophosphate		
			50	10	1.2
13	PEI/PPE/LCP	20/20/10	Calcium pyrophosphate		
			50	10	1.2
14	PA/PPE	25/25	Calcium pyrophosphate		
			50	10	1.2

TABLE 6

Comparative Example No.	Kneading Conditions		Injection Nozzle Temperature
	Temperature	Rotation	
	(°C)	rpm	(°C)
1	320	100	340
2	320	100	340
3	320	100	340
4	320	100	340
5	320	100	330
6	320	100	340
7	330	100	340
8	290	150	300
9	290	150	300
10	250	150	250
11	300	100	330
12	300	100	330
13	310	100	330
14	290	100	300

TABLE 7

Comp. Example No.	Chemical Etching Conditions				Surface	Evaluation of plated film		
	Soln.	Conc.	Temp. (°C)	Time (min)	Peelability	Appearance		Adhesion
						Uniformity	Swelling	(Kg/cm)
1	Acq.NaOH	10N	80	120	X	X	X	0.23
2	Conc.H_2SO_4		25	15	◎	◎	◎	1.85
3	Conc.H_2SO_4		25	15	○	○	○	1.46
4	Conc.H_2SO_4		25	15	○	○	○	1.50
5	Acq.NaOH	10N	80	120	△	○	○	1.30
6	Acq.NaOH	10N	80	120	○	○	○	1.19
7	Conc.H_2SO_4		25	15	◎	◎	◎	1.86
8	Conc.H_2SO_4		25	15	△	○	○	1.10
9	Conc.H_2SO_4		25	15	◎	○	○	1.26
10	Conc.H_2SO_4		25	15	◎	◎	◎	1.36
11	Conc.H_2SO_4		25	15	◎	◎	◎	1.45
12	Conc.H_2SO_4		25	15	◎	◎	◎	1.65
13	Conc.H_2SO_4		25	15	◎	◎	◎	1.80
14	Conc.H_2SO_4		25	15	◎	◎	◎	1.47

TABLE 8

(Upper row: Dielectric constant Lower row: Dielectric loss tangent)					
Comparative Example No.	1 MHz	10 MHz	1 GHz	10 GHz	20 GHz
1	4.51 0.032	4.44 0.033	4.41 0.035	4.40 0.039	4.28 0.042
2	4.48 0.028	4.42 0.028	4.36 0.029	4.35 0.030	4.35 0.033
3	3.99 0.015	3.97 0.015	3.96 0.016	3.96 0.016	3.95 0.018
4	4.15 0.019	4.14 0.018	4.10 0.022	4.10 0.021	4.09 0.021
5	4.49 0.035	4.43 0.034	4.42 0.036	4.41 0.036	4.35 0.036
6	4.20 0.022	4.20 0.022	4.18 0.024	4.18 0.025	4.15 0.025
7	4.69 0.033	4.67 0.034	4.65 0.035	4.61 0.035	4.60 0.038
8	4.15 0.018	4.15 0.018	4.14 0.020	4.12 0.021	4.12 0.024
9	4.28 0.009	4.26 0.010	4.25 0.012	4.25 0.012	4.24 0.013
10	4.59 0.033	4.58 0.033	4.52 0.032	4.50 0.034	4.48 0.035
11	4.39 0.029	4.38 0.029	4.35 0.031	4.31 0.033	4.30 0.034
12	4.45 0.031	4.41 0.035	4.39 0.036	4.38 0.037	4.38 0.037
13	4.50 0.033	4.46 0.035	4.42 0.036	4.41 0.036	4.40 0.037
14	4.40 0.030	4.40 0.031	4.38 0.033	4.32 0.035	4.30 0.036

<u>Evaluation and Comparison of Plating Characteristics</u>

Samples of Examples 1-54 comprise commercially available resins, polymer alloys, and aluminum borate or amorphous silica with a specific size and shape. Samples of Comparative Examples 1-14 were made by blending conventional inorganic fillers.

Although the required plate adhesion strength differs depending on the application, the strength should be at least about 1 kg/cm. As can be seen in Tables 3-1 to 3-4, no test leaves of Examples 1-54 were peeled in the surface peela-

bility test after etching with alkali (a KOH aqueous solution). In addition, all these test leaves exhibited an adhesion strength greater than 1 kg/cm.

As can be seen in Tables 5 and 7, the composition of the Comparative Example 1 blended with glass fiber exhibited peeling of the surface layer after chemical etching, indicating poor plating strength. The external appearance of the plated surface was also poor. On the other hand, Tables 5 and 7 show that all test leaves of the Comparative Examples 2-14 exhibited adequate plating characteristics. There was no peeling in the surface peelability test after chemical etching and all these test leaves exhibited an adhesion strength greater than 1 kg/cm.

Evaluation and Comparison of Electrical Characteristics

As indicated in Tables 4-1 to 4-4, test leaves made from compositions of Examples 1-54 comprising aluminum borate or amorphous silica had a dielectric constant of 4.0 or less at all wavelengths. Some exhibited a dielectric constant of 3.0 or less. In addition, all these test leaves had a dielectric loss tangent of 0.01 or less, showing superior electrical characteristics of the resin composition of the present invention comprising aluminum borate or amorphous silica.

In contrast, as can be seen in Table 8, all test leaves of the Comparative Examples 1-14 exhibited both a high dielectric constant and a high dielectric loss tangent, indicating remarkably impaired electrical characteristics for these test leaves as compared with those of the present invention.

As illustrated above, the resin composition for plating of the present invention has both excellent plating characteristics and excellent electrical characteristics. The composition is useful as a material for electric and electronic parts used in high frequency ranges.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

Claims

1. A resin composition for plating comprising a thermoplastic resin and at least one inorganic filler selected from the group consisting of aluminum borate of the following chemical formula:

$$nAl_2O_3 \cdot mB_2O_3 \qquad (1)$$

wherein n and m individually represent an integer of 1-100, and amorphous silica of the following chemical formula:

$$SiO_2 \qquad (2).$$

2. The resin Hermann Berstorff Maschinenban GmbH composition for plating according to claim 1, wherein the inorganic filler has an aspect ratio of 10 or less and an average diameter of 0.01-100 μm.

3. The resin composition for plating according to claim 1 containing 5-70 wt% of the inorganic filler.

4. The resin composition for plating according to claim 1, wherein the thermoplastic resin is a polymer alloy consisting of polyether imide and polyphenylene ether.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 4407

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE-A-44 22 652 (COSMO OIL CO LTD ;COSMO SOGO KENKYUSHO KK (JP)) 5 January 1995 * page 18 - page 19; tables 1-1,1-2 * * claims 1,4 * ---	1-4	C08K3/36 C08K3/38 C08L71/12 C08L79/08 //(C08L71/12, 71:12,79:08), (C08L79/08, 71:12,79:08)
X	DATABASE WPI Derwent Publications Ltd., London, GB; AN 93-261809 XP002008860 & JP-A-05 179 100 (MITSUBISHI PETROCHEMICAL CO LTD) , 20 July 1993 * abstract * ---	1-3	
X	DATABASE WPI Derwent Publications Ltd., London, GB; AN 95-128602 XP002008861 & JP-A-07 053 914 (MITSUBISHI PETROCHEMICAL CO LTD) , 28 February 1995 * abstract * -----	1-3	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

C08K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 July 1996	Siemens, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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